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Sound production through elastic instabilities in the aeroelastic tymbals of ermine moths

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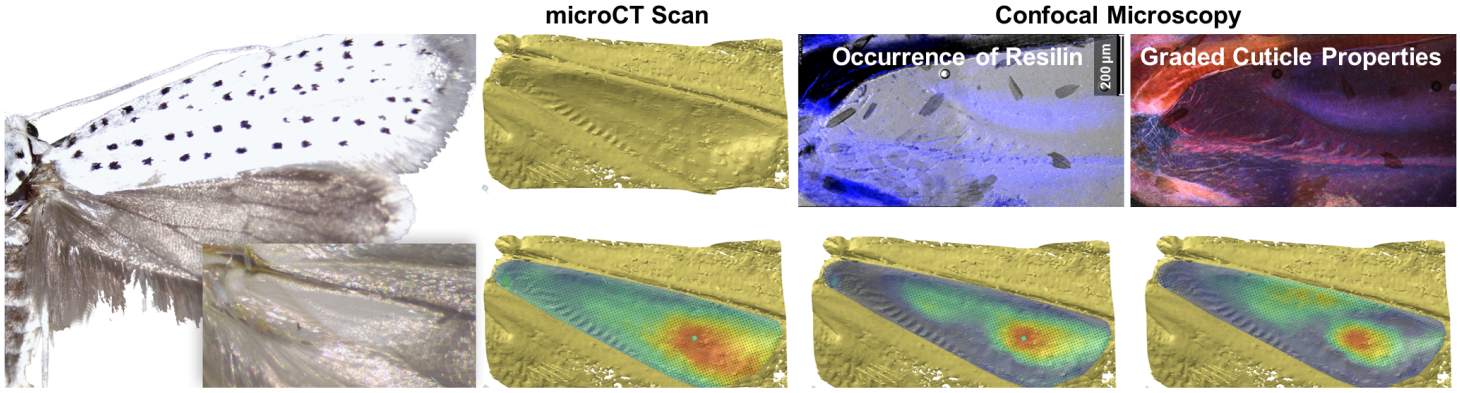
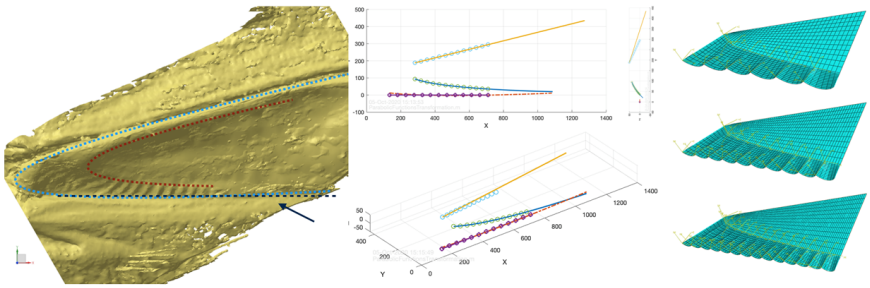
Ermine moths (Yponomeutidae) produce anti-bat sounds using their wingbeat-powered tymbals [1]. The aeroelastic tymbal buckles sequentially, producing a series of snaps that give rise to a burst of ultrasonic clicks. Here, we present a larger scale biomimetic model (x500) that emulates the buckling mechanism involved in the sound production. To achieve this, first, we studied the kinematics of the wing and carried out experimental studies on the morphology, the dynamic behaviour that leads to the sound radiation, and direct manipulation to induce buckling.

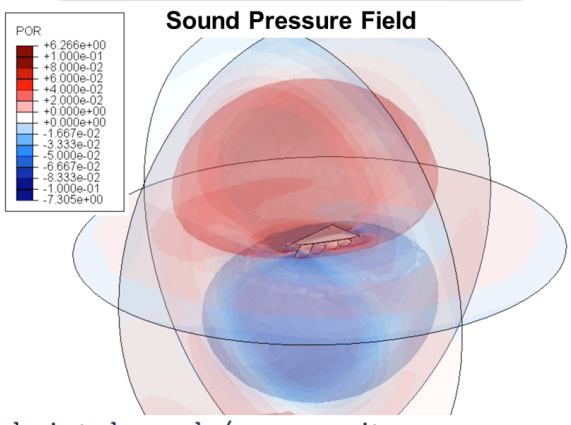
[1] O'Reilly, 2019. Scientific Reports (9:1444)

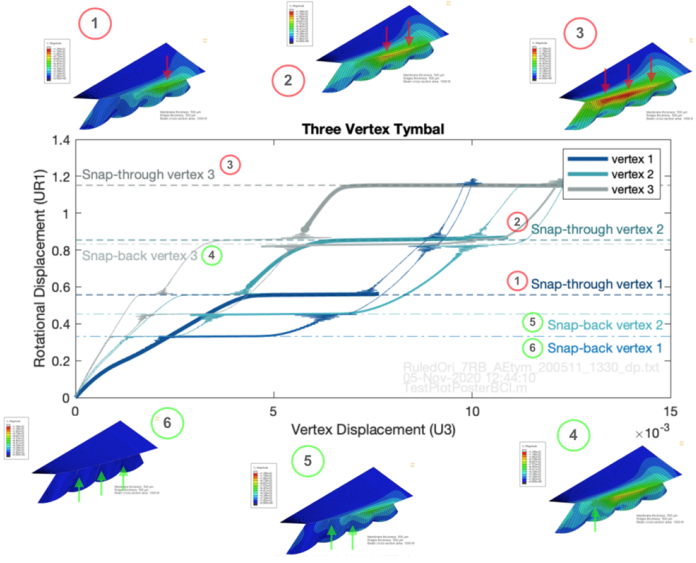


Structural-Acoustic Coupled Model

We reproduced the sequential buckling using an origami prototype. Subsequently, we developed a finite element model based on non-rigid origami principles, which takes advantage of the geometrical characteristics of the tymbal to enable the controlled and progressive succession of snap-through events. A transient structural-acoustic coupled simulation shows the sound production of the bioinspired origami tymbal.







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